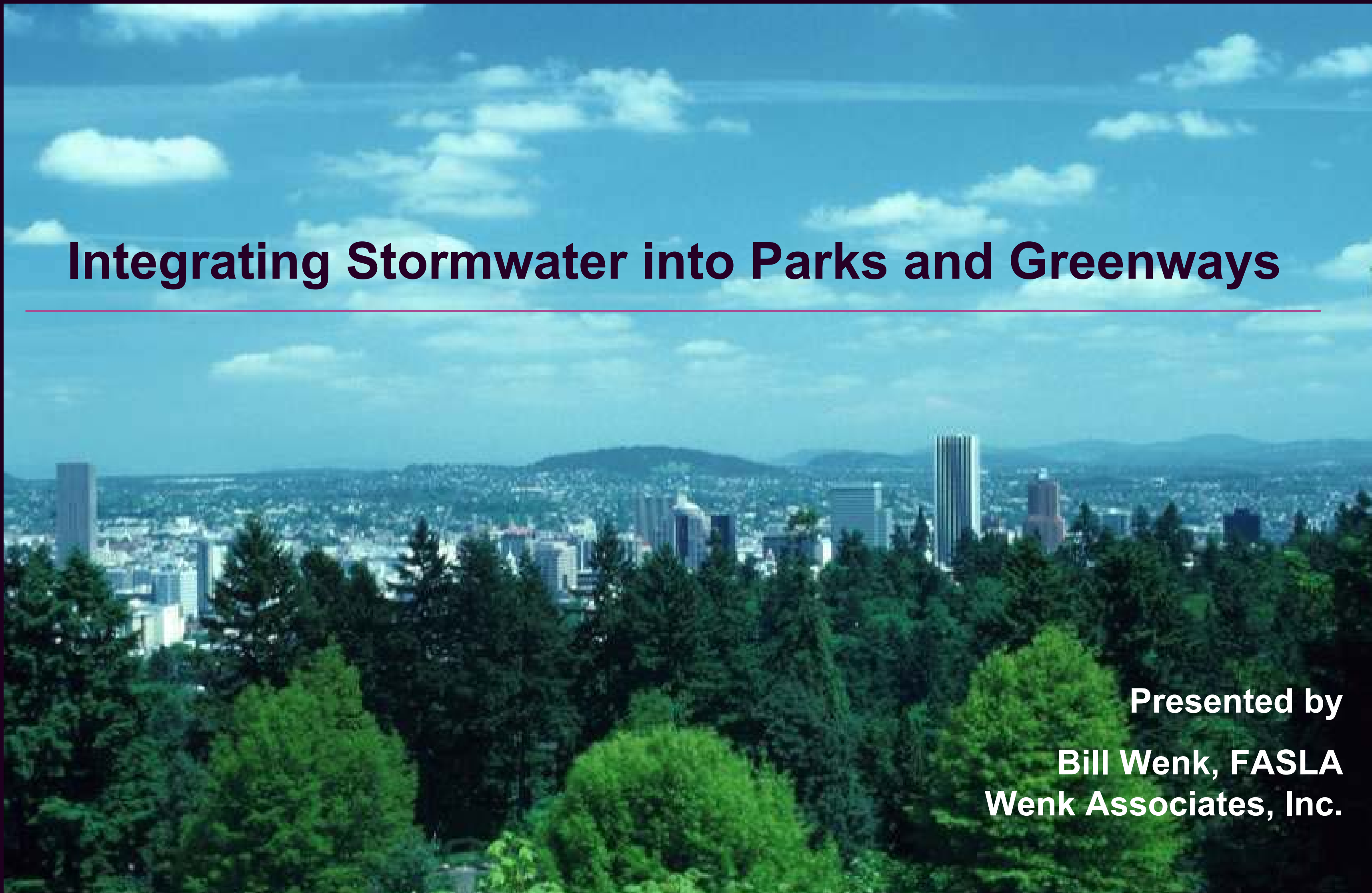
Integrating Stormwater into Parks and Greenways



Presented by

Bill Wenk, FASLA
Wenk Associates, Inc.

City of Wichita, Department of Public works

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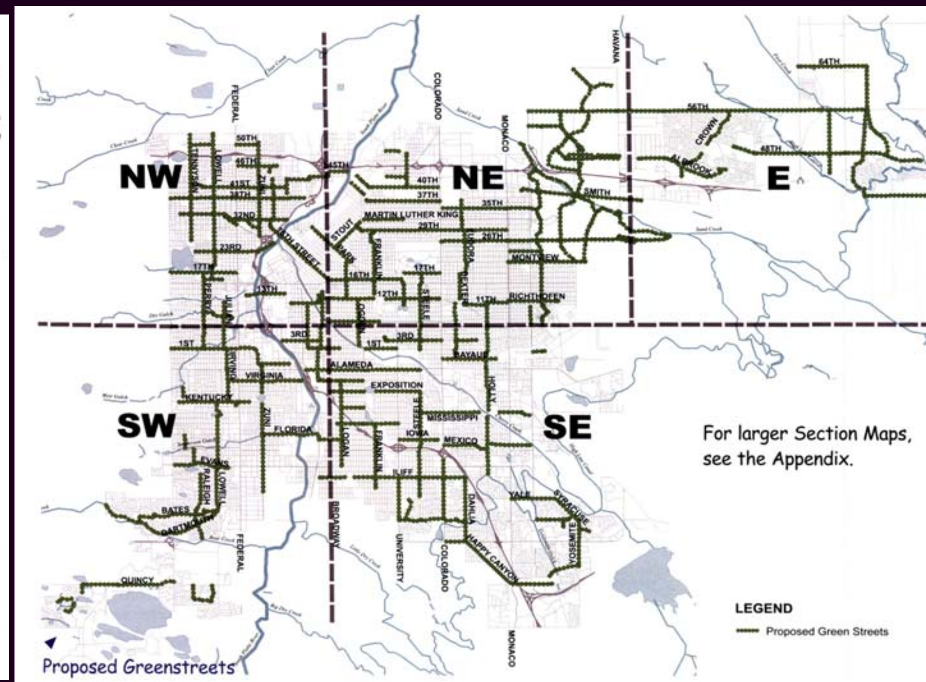
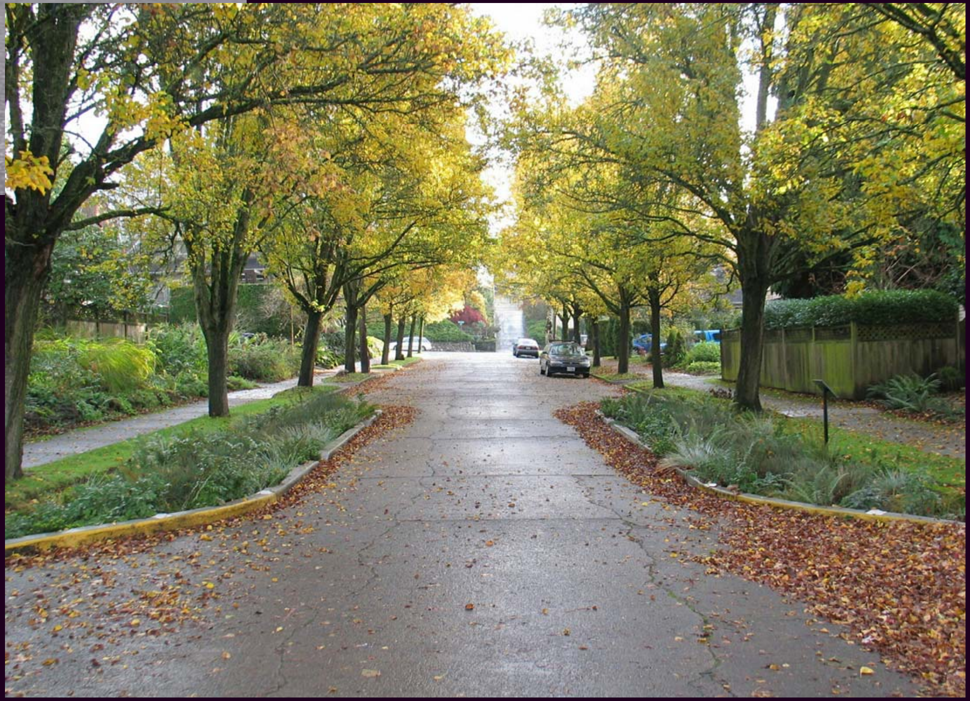


GREEN STREETS

Portland, OR – NE Siskyou Street

Kevin Robert Perry, ASLA

Before



After

GREEN STREETS

w e n k

Portland, OR – 12th Avenue

Kevin Robert Perry, ASLA

MULTI-FUNCTIONAL STORMWATER

MULTI-FUNCTIONAL STORMWATER

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Horseshoe Park - Denver

MULTI-FUNCTIONAL STORMWATER

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MULTI-FUNCTIONAL STORMWATER

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Bible Park - Denver

MULTI-FUNCTIONAL STORMWATER

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Hutchinson Park - Denver

MULTI-FUNCTIONAL STORMWATER

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MULTI-FUNCTIONAL STORMWATER

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Dragons Teeth drop structure

MULTI-FUNCTIONAL STORMWATER

George Wallace Park - Denver

MULTI-FUNCTIONAL STORMWATER

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MULTI-FUNCTIONAL STORMWATER

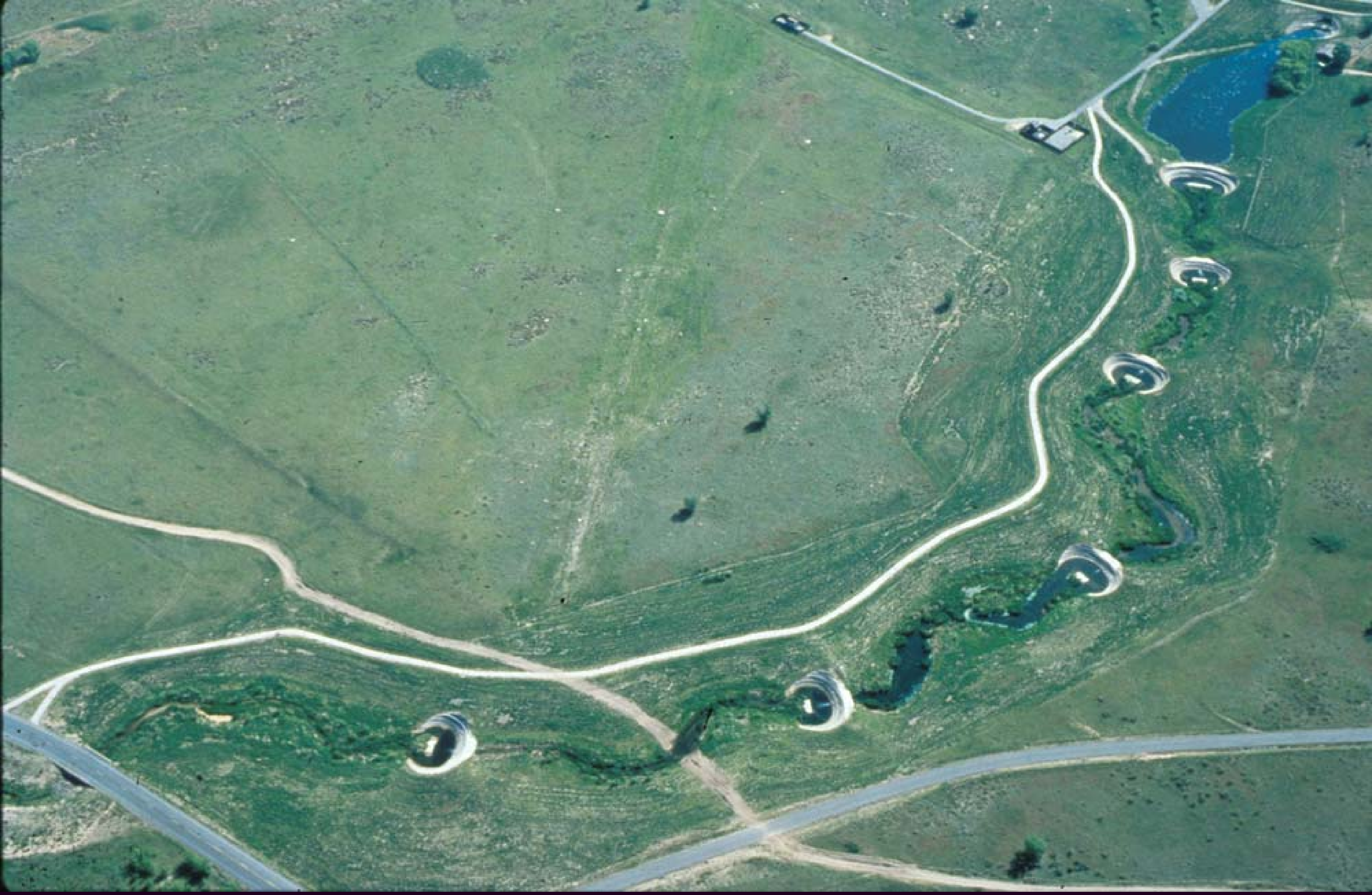
MULTI-FUNCTIONAL STORMWATER

Shop Creek - Denver

Before

After

MULTI-FUNCTIONAL STORMWATER



MULTI-FUNCTIONAL STORMWATER

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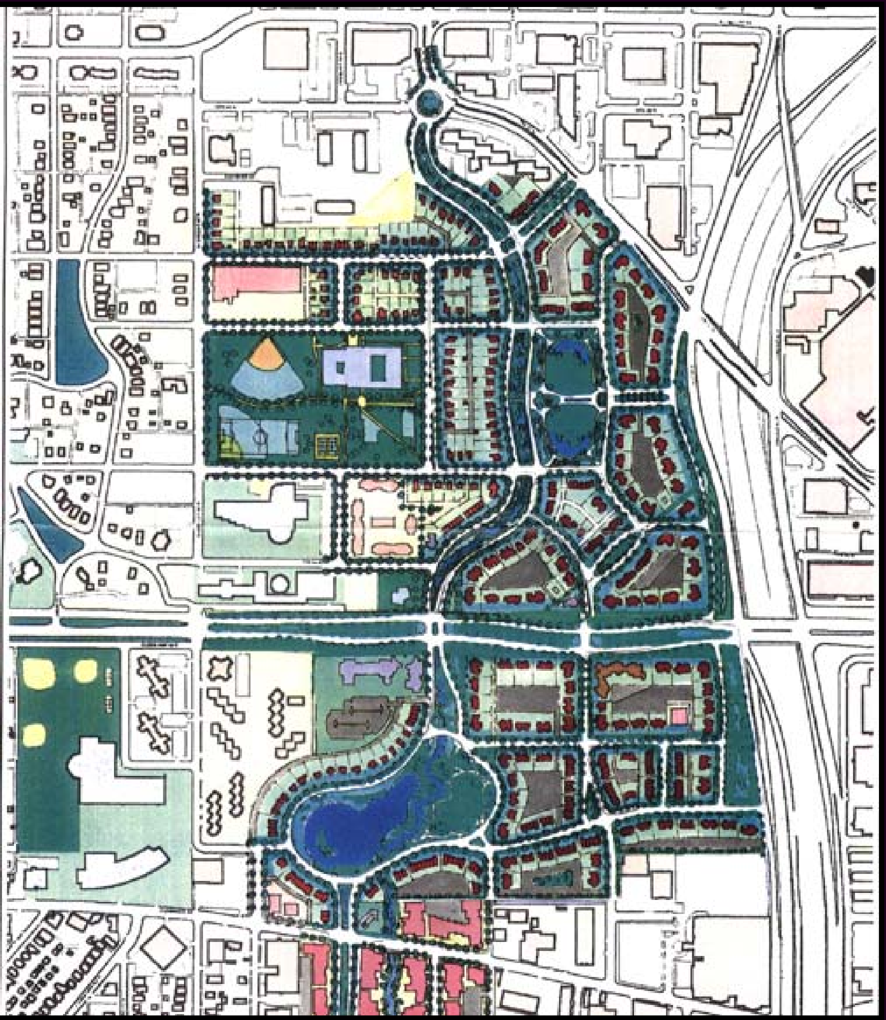
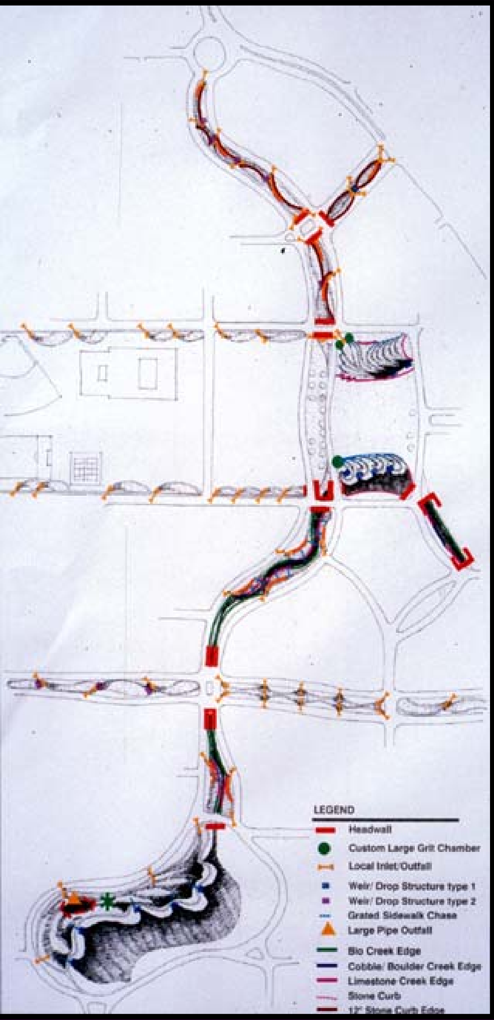


Heritage Park – Minneapolis, Minnesota

MULTI-FUNCTIONAL STORMWATER



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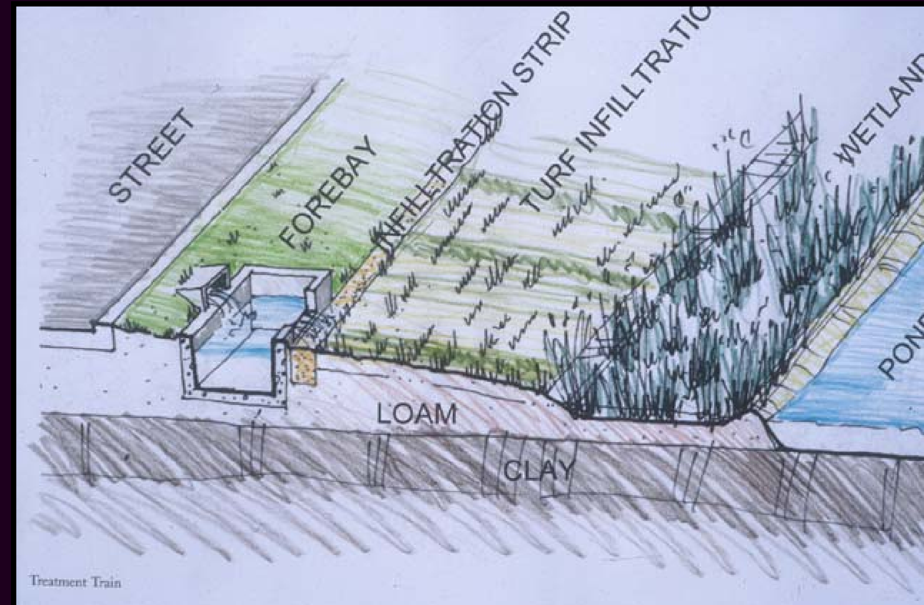

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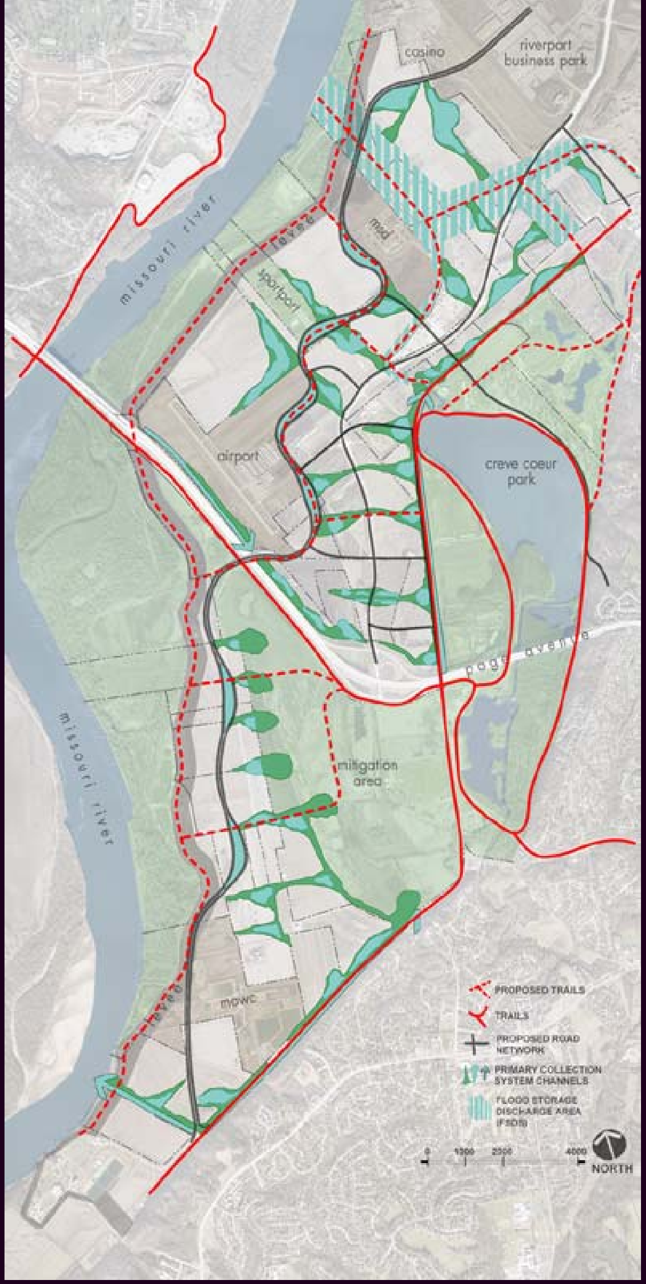
Howard Bend – St. Louis, Missouri

MULTI-FUNCTIONAL STORMWATER



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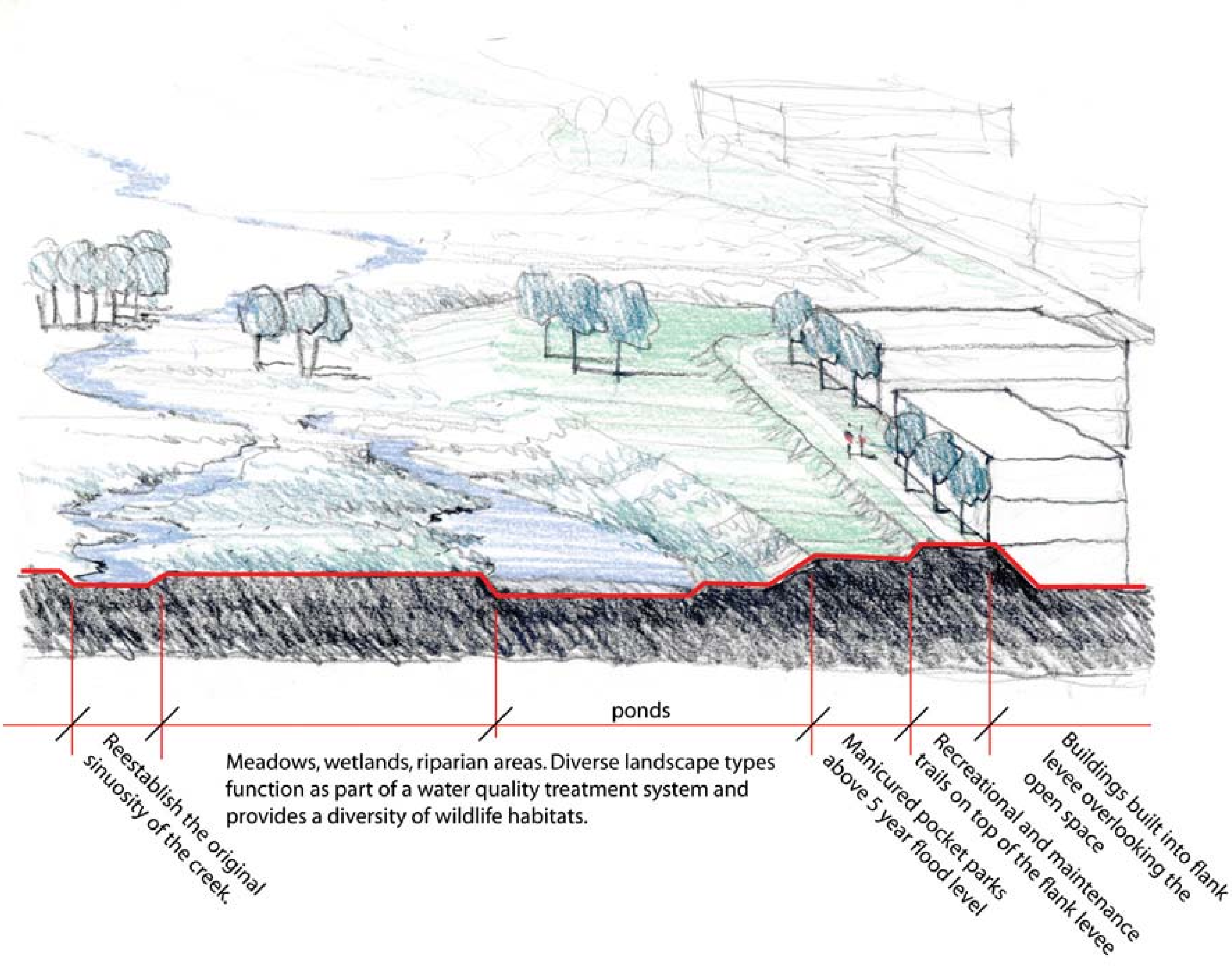

MULTI-FUNCTIONAL STORMWATER

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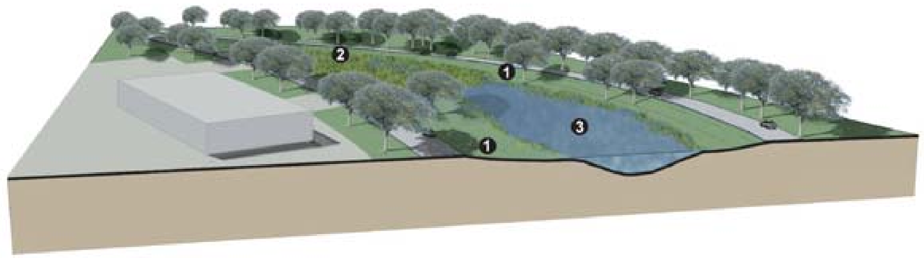
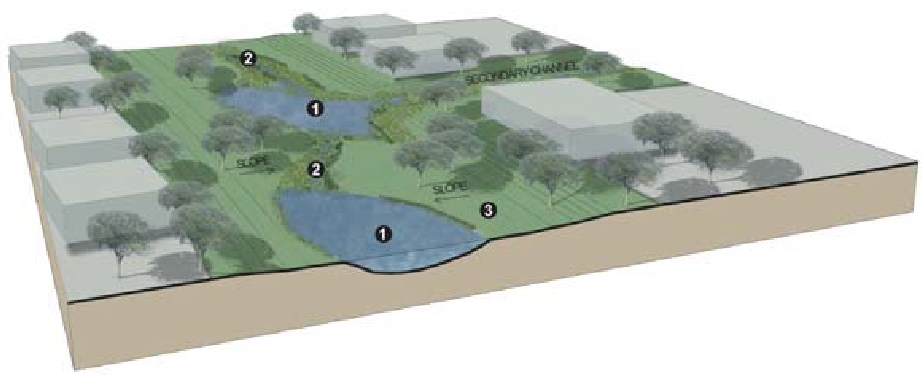
STORMWATER/ PARKWAY INTEGRATION



1. VARY CHANNEL SIDE SLOPES AND THE RELATIONSHIP OF BANK TOP AND ROAD EDGE TO AVOID AN "ENGINEERED" APPEARANCE
2. SEDIMENT FOREBAYS SHOULD BE INCORPORATED TO REINFORCE OVERALL AESTHETIC QUALITIES OF PARKWAY CHARACTER AND TO ALLOW EASY MAINTENANCE
3. LIMIT PERMANENT POOL AREAS TO AVOID SEASONAL DRYING AND TO ALLOW PASSIVE RECREATIONAL USE

INTERNAL CHANNEL



1. LOCATE PERMANENT POOLS AT AREAS OF FLOW CONCENTRATION AND LIMIT POOL SIZE TO MINIMIZE SEASONAL DRYING
2. CONCENTRATE FREQUENT STORM FLOWS TO ALLOW MULTIPLE USE OF CHANNEL BOTTOM AND TO MINIMIZE MOSQUITO BREEDING AREAS
3. MAXIMIZE STORAGE/ CONVEYANCE CAPACITY WHILE MAINTAINING POSITIVE DRAINING SIDE SLOPES

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MULTI-FUNCTIONAL STORMWATER

Prairie Trail – Ankeny, Iowa

MULTI-FUNCTIONAL STORMWATER

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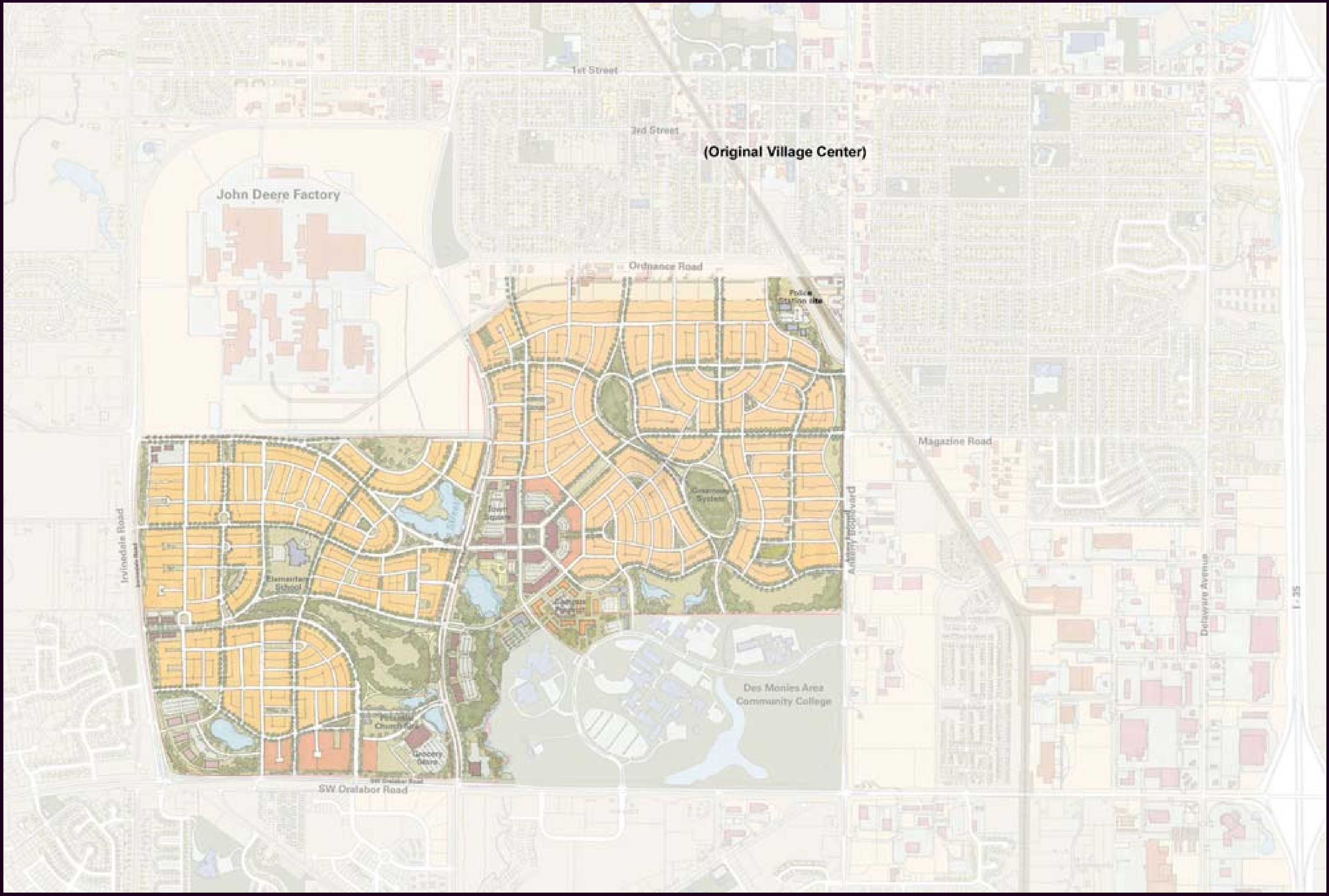

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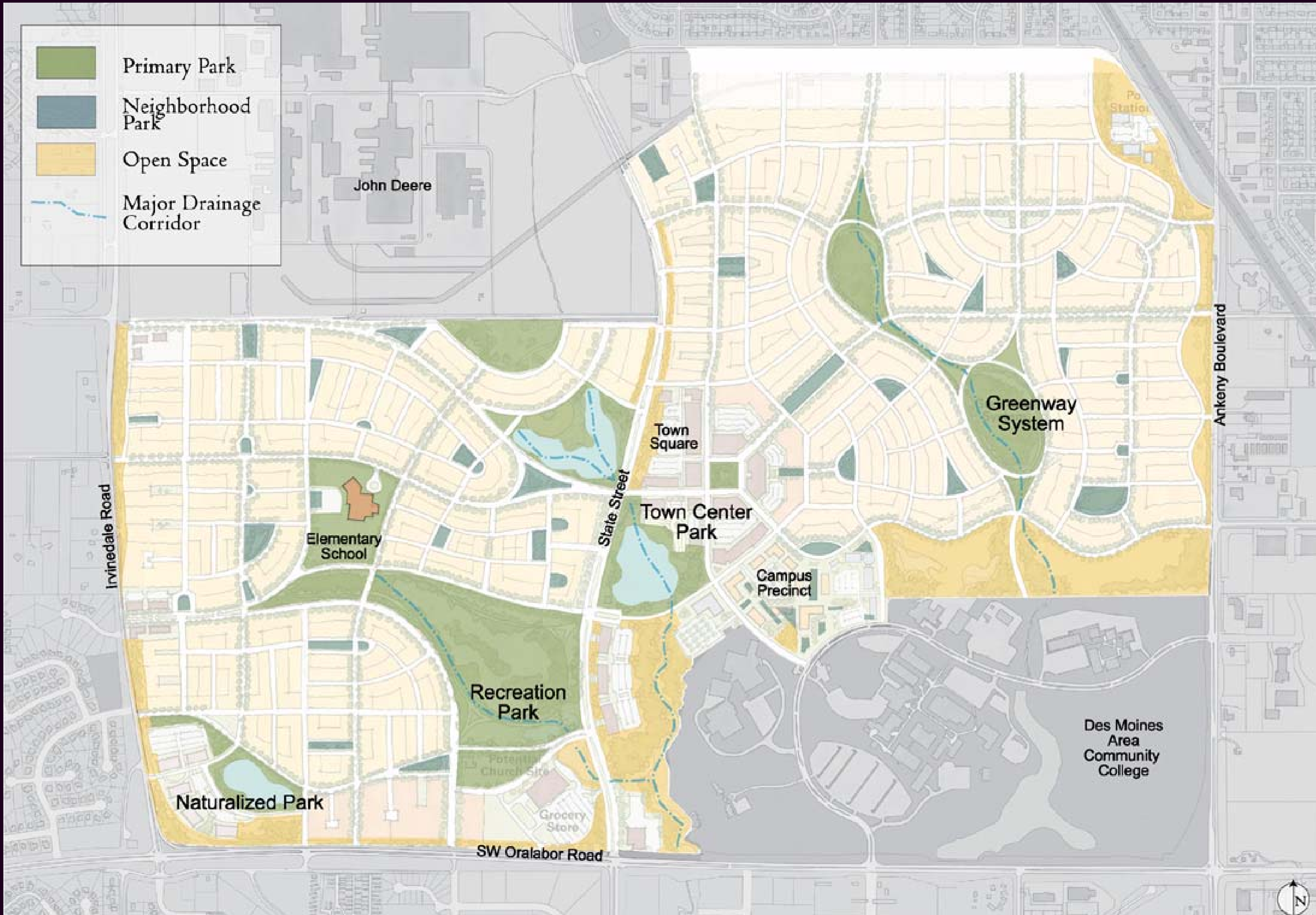

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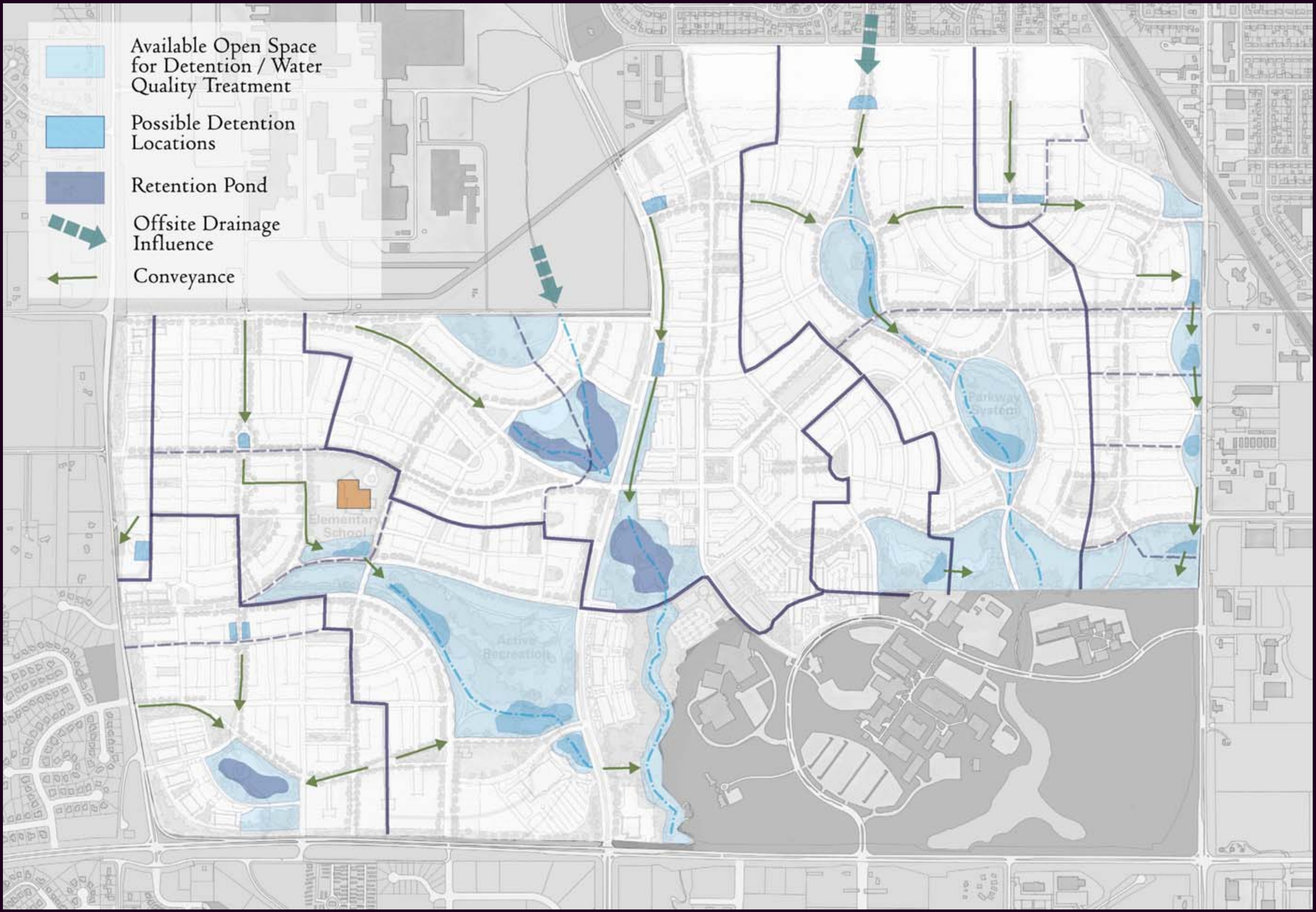

MULTI-FUNCTIONAL STORMWATER

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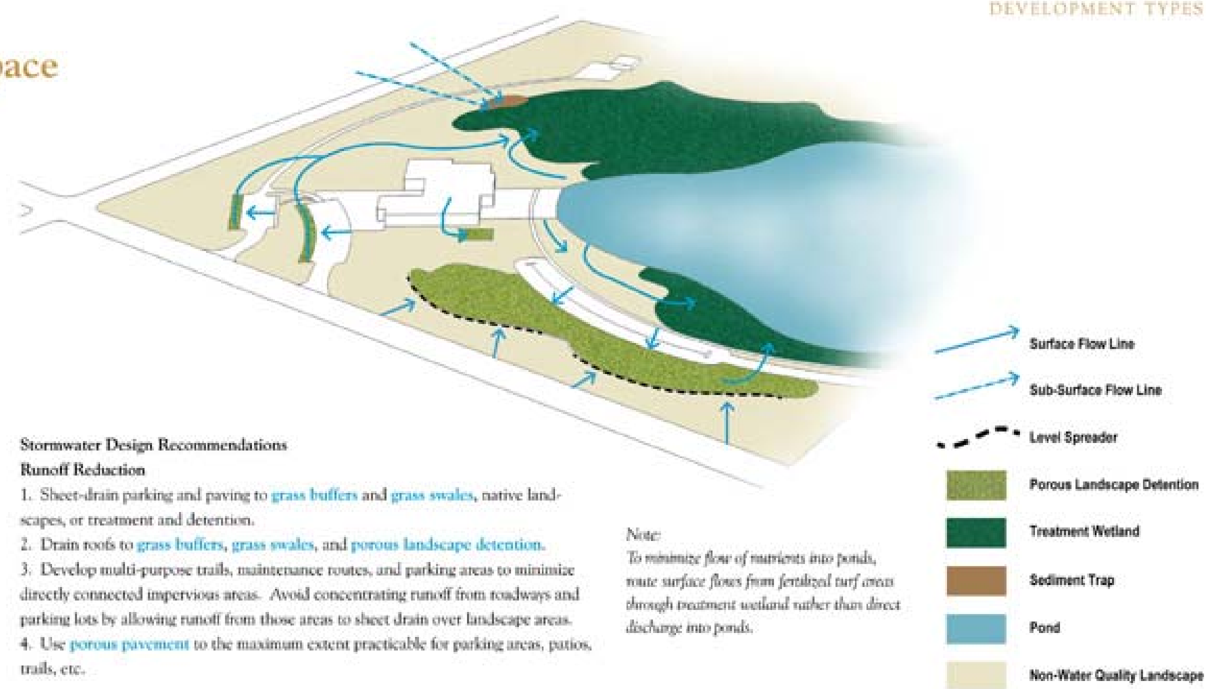
Parks and Natural Areas / Open Space



Characteristics: Due to the minimal amount of impervious area in parks, supplemental efforts to reduce runoff from on-site sources are rarely required. Parks and open spaces in Prairie Trail will serve as some of the primary locations for consolidated treatment and detention. These guidelines assume that detention and treatment will be an integral part of the parks recreational program, and be fully accessible to park users. The incorporation of treatment and storage assumes significant portions of the parks will be of a more naturalized character. Parks with high intensity uses adjacent to the Town Center may have significant areas of surface parking or paved area runoff requiring treatment.

Potential Stormwater Quality Treatment Sites: The public nature of park spaces create an opportunity for reducing and treating consolidated runoff in regional facilities. Locate treatment and storage to support the use and character of each park and adjacent development. For example, wetland treatment can serve to screen large parking areas, or to provide a buffer between residential and heavily used and programmed park facilities.

Site Design:

A. Direct all sheet flows from pavements, buildings, and turf areas through **porous landscape detention**, or related treatment prior to discharge into ponds and streams.
B. Consolidated detention and treatment should be located to accommodate traditional park uses.
C. Continuously link naturalized treatment, storage, and conveyance to Saylor Creek to promote wildlife habitat; develop a diverse range of native landscape types to accommodate a broad range of wildlife species.
D. Locate **treatment wetlands** and **porous landscape detention** to allow visual surveillance of actively used park areas from adjacent areas. Integrate trails and maintenance access. Make routes visible from roadways and adjacent development.
E. Comply with pond edge design guidelines for constructed **wetland basins**.
F. Provide sediment traps and cleanouts where stormwater pipes daylight.
G. Route runoff from turf areas through **treatment wetlands** and **landscape buffers** rather than direct discharge into ponds.

Stormwater Design Recommendations

Runoff Reduction

1. Sheet-drain parking and paving to **grass buffers** and **grass swales**, native landscapes, or treatment and detention.
2. Drain roofs to **grass buffers**, **grass swales**, and **porous landscape detention.**
3. Develop multi-purpose trails, maintenance routes, and parking areas to minimize directly connected impervious areas. Avoid concentrating runoff from roadways and parking lots by allowing runoff from those areas to sheet drain over landscape areas.
4. Use **porous pavement** to the maximum extent practicable for parking areas, patios, trails, etc.

WQv Treatment

5. Treat runoff from parking lots and roadways using **porous landscape detention** and **porous pavement detention** where practicable.
6. Incorporate regional stormwater quality treatment as part of **extended detention basins**, **constructed wetlands**, and retention ponds. Construct all facilities as site amenities, with WQv surcharges two feet or less to support diverse ecology. Minimize use of retention ponds as primary treatment for WQv to maintain a higher level of water quality in the permanent pool.
7. Do not vegetate WQv facilities with regularly mown turf.
8. Implement source control BMPs through proper pesticide, herbicide, fertilizer and other chemical use.

Note:
To minimize flow of nutrients into ponds, route surface flows from fertilized turf areas through treatment wetland rather than direct discharge into ponds.

Flood Detention / Conveyance

9. Avoid locating regularly mown turf grass areas below the five-year storm level in retention ponds, or as determined by parks department or entity maintaining turf areas.

Implementation Details

10. Direct runoff from parking to adjacent landscape areas.
11. Parks present a tremendous opportunity to include ecologically diverse plant communities in larger treatment areas. Coordinate the design of ponds and **constructed wetlands** with goals for the creation of habitat types determined in the park design process.

*NOTE: Words in **blue bold** appear in the BMP Fact Sheet section of this report. Words in **red bold** appear in the Implementation Detail section of this report.

MULTI-FUNCTIONAL STORMWATER

Stream Channel Stabilization

Sites that encompass or are adjacent to major drainageways need to preserve and enhance natural stream functions, provide adequate flood capacity, and protect the channel from degradation. SUDAS provides design criteria for major drainage improvements and constructed wetland channels. "Soft" stream restoration techniques utilizing channel shaping and riparian vegetation, as well as appropriately designed grade control structures, are favored over more structural approaches to help enhance water quality and aesthetics.

Healthy streams and drainageways, if managed well, provide a number of important functions and values, including the following listed at the right:

(left) *Goldsmith Gulch (Denver) prior to stabilization. Increased volumes destabilized the channel, resulting in "head cutting".*
(below) *Goldsmith Gulch following stabilization and reconstruction. A series of check structures have flattened the gradient of the low flow channel, slowing the velocity of small storm events and creating a stable channel. Lowering the velocity of frequent storms allows the establishment of wetland and riparian vegetation, which can withstand damage from larger storms.*

- Conveyance of baseflow and storm runoff;
- Moderation of flood velocities and associated erosion;
- Attenuation of peak flows though channel storage;
- Support of riparian and wetland vegetation;
- Creation of habitat for wildlife and aquatic species;
- Infiltration and groundwater recharge;
- Enhancement of water quality;
- Reduction of ongoing maintenance requirements;
- Corridors for trails and open space;
- Aesthetic amenities;
- Enhancement of adjacent property values and improved quality of life.

Degradation of drainageways from increased urban runoff creates adverse water quality impacts by mobilizing significant quantities of sediment and associated pollutants and conveying them to downstream receiving waters. Stream degradation is best prevented before it begins. If significant erosion has already occurred, mitigation and repair must take place utilizing appropriate stabilization improvements and taking into account the root causes, including increased base flows and peak flows. In addition to providing adequate flood conveyance and channel stabilization, these improvements should provide all of the benefits listed above that are associated with healthy stream systems.

While the water quality treatment BMPs discussed in this volume are key components in the strategy to protect our waterways, even more important is the maintenance of a stable and healthy drainage network. In addition to the value that streams and stream corridors provide to communities for recreation, aesthetics, and property values, healthy streams and ponds can provide a significant water quality benefit, while deteriorating streams can contribute significantly to water pollution problems. Degradation of streams and ponds from the effects of urbanization is inevitable, however, unless there are very strict controls on runoff volumes, proactive protection of existing drainageways, and a forward thinking approach to the design of new channels.
The increased runoff volumes and peak flows that come with urbanization increase stream velocity and energy, causing channels to erode. Depending on the nature of the existing channel, erosion can occur downwardly ("head cutting") or horizontally (bank erosion). Both types of erosion often result in steep vertical bank that are prone to constant degradation due to the lack of vegetation that can establish itself on the constantly moving and failing banks.

Although the sediment introduced into the stream system by channel erosion is from a "natural" source (the stream bank or bed), this sediment can have major detrimental effects on the water quality of streams and ponds. Not only is the sediment itself a problem for fish, macroinvertibrates and other creatures that live in the streams and ponds, but also the sediment carries with it nutrients and other potentially detrimental compounds that contribute to the pollution of steam flows and the eutrophication of

(right)
Grange Hall Creek (Denver) prior to stabilization.
(far right)
Grange Hall Creek check structure installed to prevent head cutting. The shotcrete structure is terraced for safety; materials blend into the natural setting. Vegetation upstream of the structure illustrates how revegetation is possible when velocities are reduced and head cutting controlled.

MULTI-FUNCTIONAL STORMWATER

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Drop and Check Structures

Drop structures and check structures are grade control structures that dissipate a stream's energy. Drop structures generally traverse the entire stream corridor, while check structures are designed to only dissipate energy in the low flow channel. These structures effectively "flatten" a stream's profile, thereby reducing flow velocities and erosion. In the real of urban channels, where drainage corridors are limited in width, and the increased runoff caused by development increases the potential for stream erosion, drop structures are a basic tool for channel design. Successful drop and check structures achieve the following:

- Integrate with and enhance surrounding environment
- Accommodate public use
- Are safe (no sharp protrusions, 30" maximum vertical drop in any one step)
- Allow migration of fish and macroinvertibrates

Each of the structures illustrated have buried cut-off walls and rip-rap or other armoring at the top and toe of the structure to maintain structural stability. Terraces, baffles, and plunge pools serve to dissipate energy of storm flows. In all of these examples except for the soil cement structure, buried rip-rap provides additional protection in large storm events.

POURED-IN-PLACE CHECK STRUCTURE

This is a modified form of a baffle chute structure designed to minimize vertical hazards. Although the structure is appropriate for its setting, the concrete low flow channel and vertical drops of the low flow channel provide no habitat value. The photo on the bottom shows the structure during a minor storm event.

SLOPED GROUTED RIP-RAP DROP STRUCTURE

This structure extends from the vertical wall on the right to a wall out of the photo on the left. Plantings are in grouted rip-rap basins. Rip-rap lining of the plunge pool at the base of the structure is buried to diminish the visual mass of the structure. The stepped low flow is a preferred design, allowing movement of fish and macro invertebrates. Terraced side slopes allow safe pedestrian access to the waters edge.

SCULPTED SHOTCRETE CHECK STRUCTURE

The small, stepped drops and pools allow movement of fish and macro invertebrates, and allow safe pedestrian water access.

SOIL CEMENT DROP STRUCTURE

The structure blends into its natural prairie setting. Small terraces created by the layered installation of soil cement makes it safe. Aquatic habitat value is limited because low flows are piped through the structure.

MULTI-FUNCTIONAL STORMWATER

Attached Residential

Characteristics: Attached residential units consist of linked, multi-story units. Driveways and parking is dispersed throughout the project in small lots with garages, courtyard gardens; small parks and perimeter landscape buffers are typical.

Potential Stormwater Quality Treatment Sites: Runoff reduction techniques, infiltration techniques, and WQv detention options should be integrated into the landscape to create site amenities where space allows. Stormwater treatment can occur at surface parking edges, landscape buffers, lawns, small parks, and gardens. Parking areas can be designed to treat both WQv and flood storage, if required, for the runoff they generate.

Notes:

- *Incorporate extended detention volumes into water quality areas that are less visible and of little value for landscape amenities.*
- *To keep infiltration facilities shallow, minimize use of pipes to convey to infiltration.*
- *Avoid facilities that are frequently wet where they conflict with pedestrian traffic or recreational uses.*
- *On-site detention may be required. Refer to the Sub-Area Design Characteristics section in the Introduction of this report to identify sub-watersheds requiring on-site detention.*

Site Planning

A. Consolidate landscape areas to allow incorporation of stormwater facilities

B. Sheet-drain large areas of paving to landscape (e.g. **grass buffers** and **swales**) to reduce runoff. Spread flows with **slotted curbs** or **level spreaders.**

D. Drain roofs, walks, and drives to **porous landscape detention** to reduce and treat runoff.

E. When the site is contiguous with open space buffers, develop plantings that create a smooth transition between the site and open space; consider joint/integrated detention if required.

F. When it isn't beneficial to utilize consolidated detention, incorporate flood detention into the site as an integral part of WQv.

Stormwater Design Recommendations

Runoff Reduction

1. **Grass buffer** as an integral component of **landscape buffers,** courtyards and plazas.
2. **Grass swale** as an integral component of parking and perimeter landscaping.

WQv Treatment

3. **Porous landscape detention** in small parks, lawn gardens, and **landscape buffers.**
4. **Detention basins** including **extended detention, sand filter basins, constructed wetlands** and retention ponds are acceptable in low visibility areas.

Flood Detention / Conveyance

5. Direct **roof** runoff to **porous landscape detention.**
6. Design **parking areas** and landscapes to accommodate their own treatment and flood detention requirements. Include shallow paving depressions of less than nine inches in parking lots to detain flood volumes, if required.
7. Combine stormwater quality treatment with flood control in **detention basins** when flood storage is not directed to consolidated detention facilities.

***NOTE:** Words in **blue bold** appear in the BMP Fact Sheet section of this report. Words in **red bold** appear in the Implementation Detail section of this report.

MULTI-FUNCTIONAL STORMWATER

Porous Landscape Detention (PLD)

1 Inlet: *Curb inlet and roof drains supply water to porous landscape detention. Sheet flow from parking lot over a grass buffer would be more cost effective and would allow reduced area requirement for the PLD.*

2 Sediment Trap: *Include a defined entrapment to remove sediments from paved areas.*

3 Slopes: *Relatively flat bottom with a 6-12 inch deep WQv zone (six inches recommended). Side slopes maximum 3:1 slope. (Slopes conveying significant sheet flow should be shallower.)*

4 Vegetation: *Varies depending on context. Native mesic prairie in natural settings, ornamental plantings that can tolerate wide variations in soil moisture in more highly developed contexts are good examples of proper planting.*

5 Underdrain/Liner: *Underdrain is required when underlying soils have insufficient infiltration capacity. Underdrain and liner are recommended where geotechnical concerns exist.*

6 Outlet/Overflow: *Provide overflow above WQv for larger storm events. (Not shown in sketch)*

7 Infiltration Matrix: *Provide in accordance with design requirements shown in Soils, Implementation Details.*

8 Adjacent Areas: *When possible, eliminate curbs or daylight roof drains and sheet drain parking, roads and roofs across grass buffer to enhance treatment.*

The landscape area in the center of the photo is a PLD. It can be incorporated into small spaces between buildings like these planters in this residential courtyard. Source: Murase Associates; City of Portland, Department of Environmental Services

This larger PLD in a medium density neighborhood gives identity to the community. Native mesic prairie shown can tolerate wet and dry periods. The sediment trap shown filled with water following a storm event in this photo, is shown on page 49 in more detail.

This PLD treats runoff from the parking area to the right of the photo. The small pocket wetland compliments the natural qualities of the stream corridor to the left, and provides an enhanced experience for trail users.

Function: To provide for Water Quality Capture Volume (WQv)

Porous landscape detention is a depressed landscape area with hydrologic soils Type A or B (sand to loam) that promotes filtration and infiltration of runoff. Also, a PLD (if not underdrained) greatly reduces runoff volume, which reduces flooding and erosion in downstream receiving waters.

Typical Applications: Parking islands, medians, and landscape buffers, courtyards, and planters. Geotechnical and foundation issues must be carefully considered when locating porous landscape detention facilities and designing underdrains and linings.

Operation and Maintenance Considerations: Sediment build-up may require periodic removal of sediments and plants when clogging reduces infiltration capacity to unacceptable levels. Access to facility must be provided to enable maintenance operations. Plant materials in areas prone to sediment build-up should be limited to grasses and groundcovers tolerant of periodic wet-dry cycles.

Landscape Considerations: A wide variety of plant types are possible, ranging from native grasses, groundcovers, flowers, and shrubs. Turf grass is discouraged because of the difficulty of maintenance. Trees should not be included in porous landscape detention areas (roots make maintenance difficult). Dense shrub plantings may become difficult to maintain, and should be limited to edges not prone to sediment build-up. Rock mulches (especially in high sediment areas) are discouraged because they limit the available pervious surface and are difficult to remove sediment from. The use of long fiber shredded wood mulch is encouraged because of a higher level of perviousness.

Relative Cost: Moderate to high

MULTI-FUNCTIONAL STORMWATER

Menomonee Valley Redevelopment - Milwaukee, Wisconsin

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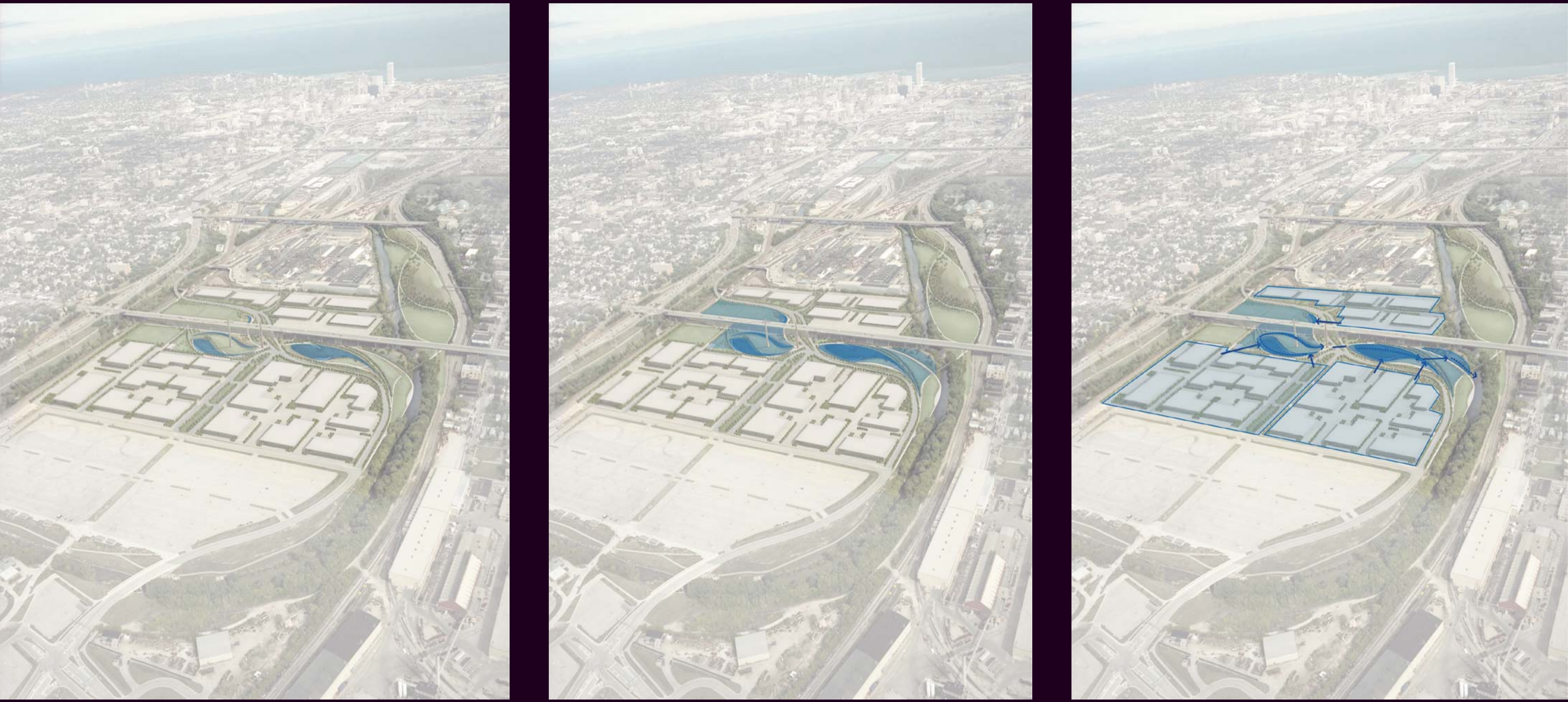

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MULTI-FUNCTIONAL STORMWATER

2-year storm event

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5-year storm event

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100-year storm event

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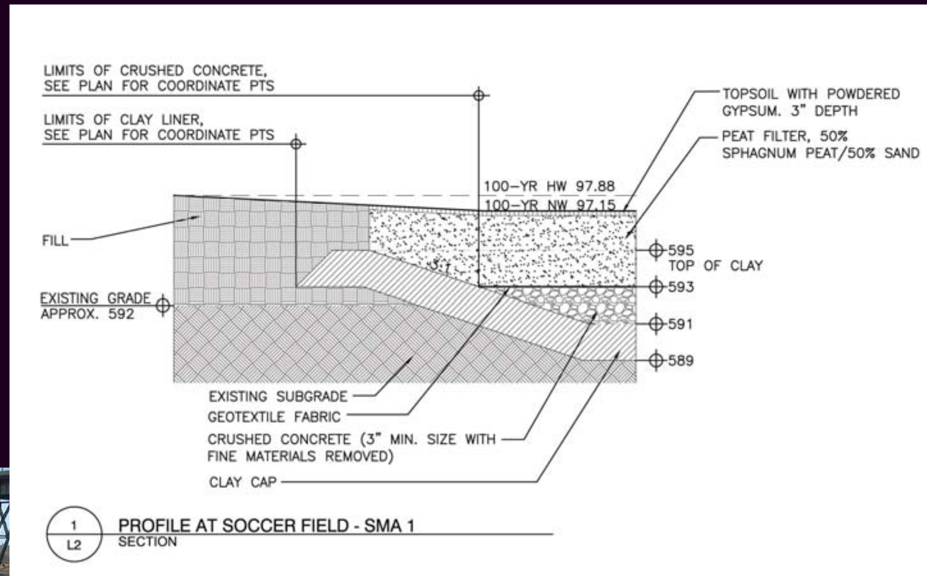

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Los Angeles River Revitalization Plan - California

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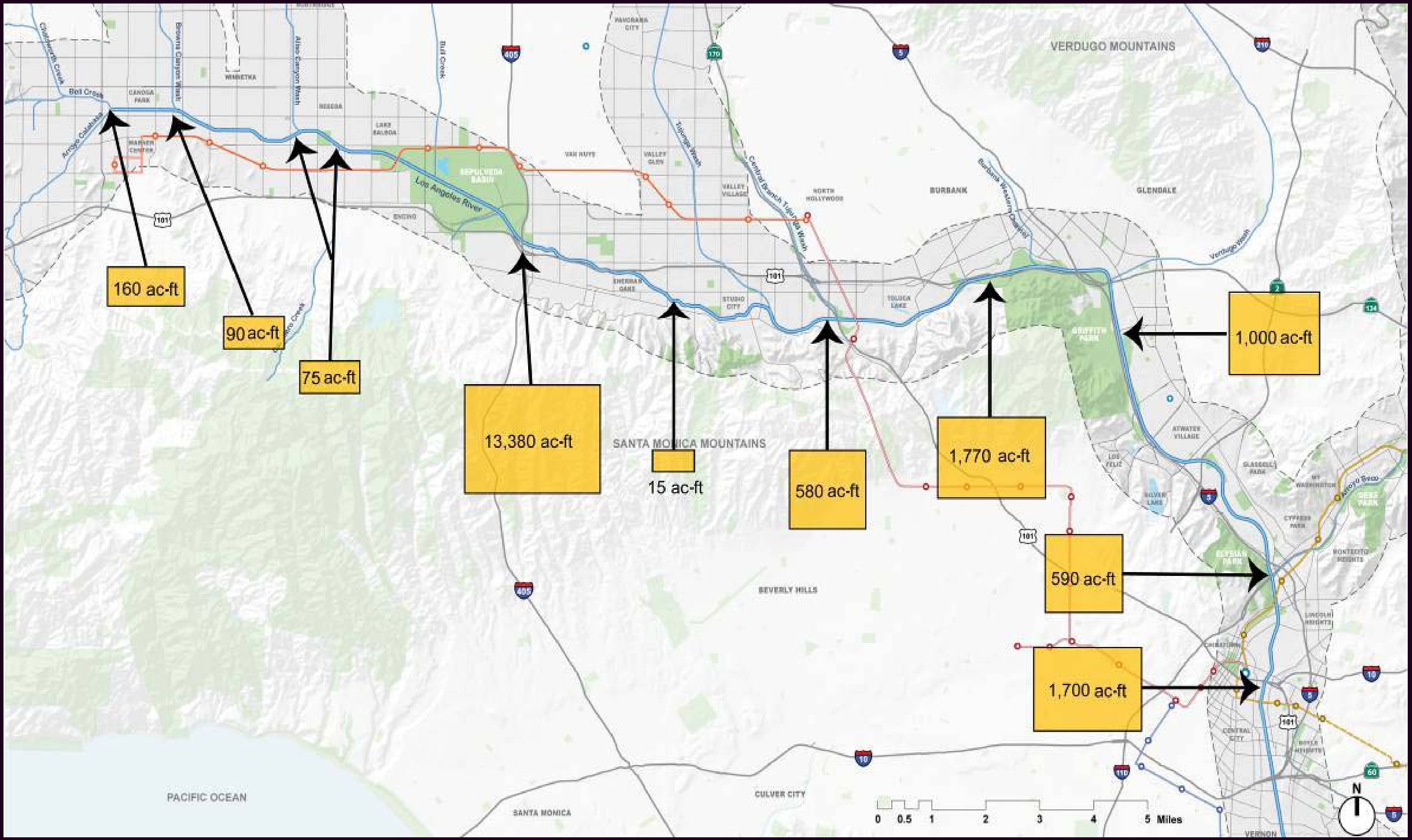

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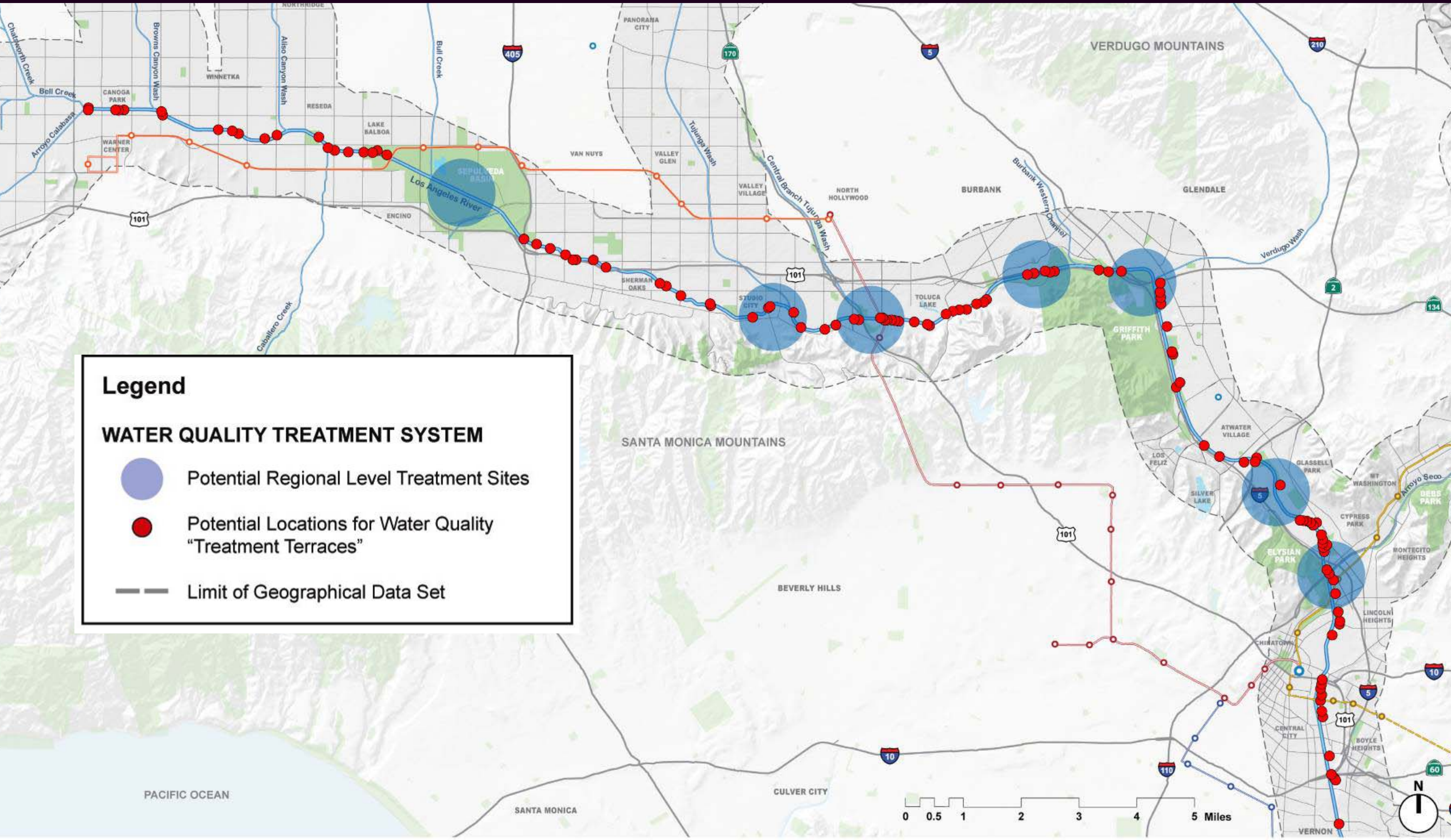

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